Section 4: Fossil Steam Unit Cost Development

4.1 Heat Input/Rate and Performance Factor

Fossil steam units with multiple boilers can use two methods to develop heat input curves.

Heat input based on the unit's entire operational range: This method uses all the historical operating data to calculate a single heat input curve. The start heat input is calculated as the heat input of starting the full configuration.

Heat input based on the unit's operation in each boiler configuration: This method uses all the historical operating data per configuration to calculate a heat input curve for each configuration. The start heat input is calculated as the heat input of starting each configuration. The configurations differ depending on the number of boilers in operation.

Section 5: Combined Cycle (CC) Cost Development

5.1 Heat Input/Rate and Performance Factor

Combined cycles with a 2x1 configuration (two combustion turbines and one steam turbine) or higher can use three methods to develop heat input curves.

1. Heat input based on the unit's entire operational range: This method uses all the historical operating data to calculate a single heat input curve. The start heat input is calculated as the heat input of starting the full configuration.
2. Heat input based on the unit's operation in each configuration: This method uses all the historical operating data per configuration to calculate a heat input curve for each configuration. The start heat input is calculated as the heat input of starting each configuration. The configurations differ depending on the number of combustion turbines in operation.
3. Pseudo heat input curve: The pseudo combined cycle model is a type of generator modeling in which a combined cycle is divided into separate units depending on the number of combustion turbines and the output of the steam turbine is assigned evenly across the combustion turbines.

   For example, a 600 MW 2x1 combined cycle comprised of two 200 MW combustion turbines and a 200 MW steam turbine can be modeled as two separate 300 MW units (200 MW for each combustion turbine plus 100 MW assigned from the steam turbine assigned evenly).

   When using the pseudo combined cycle model, the heat input curve must be adjusted. A typical heat input curve is defined by a quadratic equation.

   Equation 1. Pseudo Combined Cycle Model Heat Input Equation.

$$Heat\ Input\ \left(\frac{MMBtu}{hour}\right) = A + B\,{}^{*}Unit\ Output\ (MWh) + C\,{}^{*}Unit\ Output^{2}\ (MWh)$$

In order to use this equation in the pseudo model, the constant coefficient (term A) must be divided by the number of combustion turbines in the combined cycle, the linear coefficient (term B) remains the same and the quadratic coefficient (term C) is multiplied by the number of combustion turbines. For example, if the equation represents a 2x1 configuration, the constant coefficient used in each pseudo model must be divided by two and the quadratic coefficient must be multiplied by two. Equation 2 shows the pseudo combined cycle model heat input equation.

Equation 2. Pseudo Combined Cycle Model Heat Input Equation.

$$Heat\ Input\left(\frac{MMBtu}{hour}\right) = \frac{A}{CT\_Count} + B * Unit\ Output\ (MWh) + CT_{Count} * C * Unit\ Output\ (MWh)^2$$

Where:
A = The constant coefficient of the heat input curve of the full configuration.
B = The linear coefficient of the heat input curve of the full configuration.
C = The quadratic coefficient of the heat input curve of the full configuration
CT_Count = Number of combustion turbines in the full configuration